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LAMBTON TGS CHIMNEY 2
CONDITION SURVEY OF CONCRETE SHELL

Report No 88-158-K

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ABSTRACT

An inspection of the concrete shell of Lambton TGS Chimney 2 was conducted in May 1988, as part of the "Life Assessment Program". On the exterior of the shell, five main cracks were identified having a maximum crack width of 0.020". Based on observations of the interior surface of the shell, some of these cracks may extend through the thickness of the concrete along a portion of their length. At the base of the shell, in the annular space, the concrete has been attacked by an acidic mixture of fly ash and water that accumulates in this area.

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To Mr. J.V. Doyle
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Attn: Mr. S.H. Liang

LAMBTON TGS CHIMNEY 2
CONDITION SURVEY OF CONCRETE SHELL

1.0 INTRODUCTION

At the request of Mr. S.H. Liang of the Civil Works Department, an inspection was undertaken by the Civil Research Department between May 3 and 10, 1988, to investigate the condition of the concrete shell of Lambton TGS Chimney 2. The inspection forms a part of the "Life Assessment Program" being carried out at Lambton TGS, and consisted of visual observations, mapping of cracks, measurement of crack widths and ultrasonic testing to determine the depth of crack penetration into the shell. At locations where the cracks had been previously repaired, the condition of the repair was also visually inspected.

This report summarizes the findings of the inspection and includes, in Figure 1, a sketch showing the location of the main cracks on the exterior surface of the concrete shell.

2.0 PROCEDURES

Access to the exterior surface of the chimney (Figure 2) was obtained using a 17 foot long pivoting swing-stage. Four drops were performed on the exterior of the chimney at the northwest, southwest, southeast and northeast quadrants. At each location, the concrete was inspected from the ground (Elevation 5') to the start of the painted portion of the chimney (Elevation 505'). The condition of the concrete around the base of the shell was also noted.

As part of the inspection, the upper and lower termini of the main cracks were identified and marked on the concrete with painted targets. The purpose of the targets is to aid in determining the propagation of the cracks when future inspections are conducted.

In the annular space, between the concrete shell and steel liner, one drop was performed to inspect the condition of the interior surface of the concrete shell. The drop was conducted on the west quadrant and access was obtained using a two-man spider cage. In addition, the concrete in the annular space at the base of the shell and the steel liner support was inspected.

3.0 OBSERVATIONS

3.1 Exterior

On the exterior surface of the concrete shell, five main cracks are present. The location of the cracks, identified as Cracks 1 to 5, is shown in Figure 1, and a brief summary is given in Table 1. The crack widths ranged from 0.020" to hairline depending on the crack and the location along its length (Figures 3 and 4).

Attempts were made, using ultrasonic pulse velocity measurements, to determine the depth of crack penetration into the concrete shell. Measurements taken across Crack 3, at Elevation 290', were not successful. At Elevation 230', on Crack 4, it was estimated that the crack extends at least 4" into the concrete shell. In general, it was difficult to obtain information on the depth of the cracks because the crack widths are generally small and contain material that interferes with the pulse velocity readings.

At the base of the chimney, several small cracks are present. The crack widths range from 0.010" to hairline (Figure 5). Most of the cracks do not extend vertically past the bottom of the breaching; however, at one location, on the northeast portion of the chimney, one extends to Elevation 90'. The depth of a typical crack at the base of the chimney was determined to be at least 5". Such cracks are not included in Figure 1 because of the small crack width and length and random orientation.

Repairs have previously been made to Cracks 3 and 5. It was reported in previous contractor's reports that the repairs had consisted of brushing on a coating of Surfacrete manufactured by Sika Canada. This material has weathered, and Crack 3 was observed to be open (Figures 6 and 7). Access to Crack 5 was difficult because of weather conditions; therefore, only the top and bottom sections of the repair could be inspected (Figures 8 and 9). The upper section of this crack was covered by paint and a dirty film obscuring the repair. The lower section of the repair has weathered, and the crack was observed to be open.

The termini of the cracks were marked with painted targets (Figure 10) with the exception of the upper termini of Cracks 3 and 5 and the lower terminus of Crack 2. The target for the upper terminus of Crack 3 was placed at Elevation 445'. At this location, the crack intersects the embedded step-irons that make up the access ladder. It was reported by the steeplejack contractor that the crack extends above this elevation intersecting the step-irons into the painted portion of the chimney. Because of restricted access, this could not be confirmed. The upper portion of Crack 5 was observed to extend into the painted portion (Elevation 505') of the chimney which made it difficult to identify (Figure 11) the upper terminus. The lower terminus of Crack 2 could not be determined; however, it probably forms part of Crack 3 at a lower elevation. In many instances, it was difficult to identify the lower terminus because of the small crack width at lower elevations (Figure 12).

One section of spalled concrete, approximately one foot square, is present north of the ladder at Elevation 440' (Figure 13). A piece of exposed steel was observed at Elevation 310' on the northwest quadrant.

The painted portion of the chimney, above Elevation 505', appears to be in good condition with no peeling of the paint. This area is covered with a dirty film, presumably from the flue gases.

3.2 Interior

One drop was conducted in the west portion of the annular space to inspect the condition of the inside surface of the shell. The surface of the concrete, over a majority of its length, is covered with a layer of fly ash up to about 1/4" thick (Figure 14). The fly ash was removed at 75-foot intervals in order to inspect the concrete surface. Near the base of the chimney, the spider cage was swung to cover about 40 feet of the circumference of the chimney. The inspection area was reduced from 40 feet at the base to 15 feet near the top of the chimney.

Two vertical cracks were noted in the concrete. One extended from Elevation 15' to 90' (Figure 15) and the other from Elevation 330' to 525' (Figure 16). The crack locations given are only approximate because of the difficulty in viewing the concrete surface. The width of the two cracks was similar, ranging from 0.030" to hairline. The location of the upper crack appears to coincide with Crack 3, noted during the external inspection.

At some locations, particularly above Elevation 225', the surface of the concrete is scaled to a depth of approximately 1/8". In other areas the surface has a chalky texture. These factors combined with the layer of fly ash make it difficult to view cracks.

Prior to this inspection, the annualar space contained about 2 feet of a fly ash-water mixture. From the base of the annular space to a height of about 1 foot, the concrete of both the shell and the base supporting the steel liner has been attacked to a depth of approximately 1/4" (Figure 17). The concrete in this area has become soft, pasty and yellow in colour. The pH of the material was found to be about 3 which indicates an acidic environment that would be expected to attack the concrete. The deterioration is generally confined to the lower portion of the shell. A few vertical cracks were also noted at the base of the concrete shell.

The steel liner is attached to a concrete base, 22 feet above the floor of the annular space. On the exterior surface, a horizontal crack extends around the circumference of the base from 3 to 4 feet above the floor (Figure 18), intersecting the imbedded drain pipes. The crack width range is between 0.030" and 0.015". Minor vertical cracks are also present. The interior surface of this base could not be inspected for cracks because of a layer of fly ash and etching of the concrete surface (Figure 19).

4.0 CONCLUSIONS

In general, the concrete shell appears to be in good condition. Five main cracks were identified on the exterior of the chimney. Based on the observations from the one drop conducted in the annular space, Crack 3 appears to extend through the concrete shell along a portion of its length. Of the four remaining, Cracks 4 and 5 may also extend through the shell at some locations.

At the base of the chimney in the annular space, the concrete is being attacked by an acidic mixture of fly ash and water.

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TABLE 1

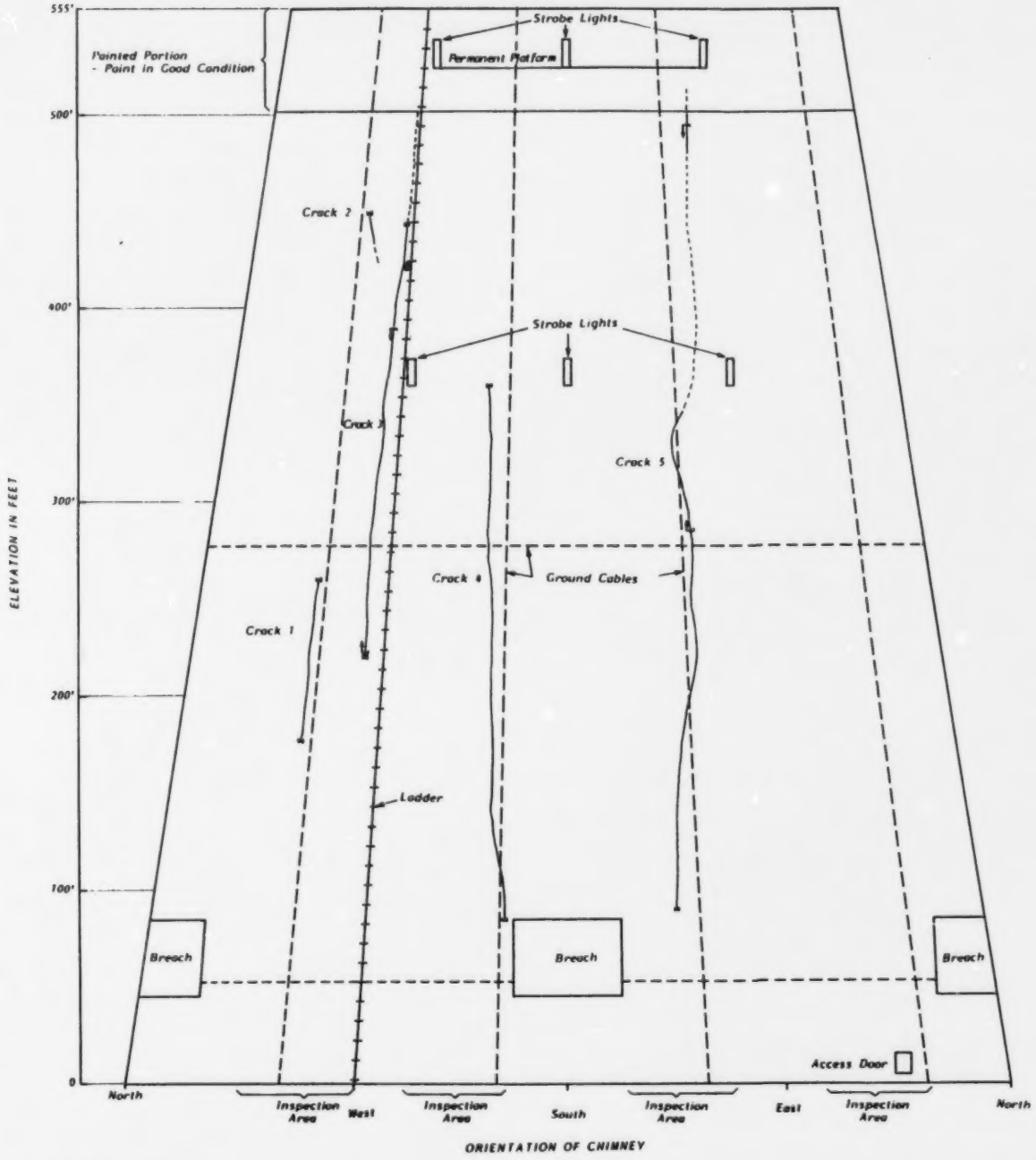
LAMBTON TGS, CHIMNEY 2
SUMMARY OF CRACKS

Crack No	Location	Elevation(ft)		Repair Elevation(ft)		Width(in)	Remarks
		Bottom	Top	Bottom	Top	(Maximum)	
Crack 1	northwest elevation	180	260	N/A	N/A	0.015	
Crack 2	northwest elevation	-	450	N/A	N/A	0.015	Bottom of crack could not be determined; probably joins Crack 3.
Crack 3	northwest elevation	220	445	220	390	0.020 to 0.010	Crack was reported by the steeplejack contractor to extend upward through the embeded step-irons into the painted portion of chimney. Because of restricted access this could not be confirmed.
Crack 4	southwest elevation	80	365	N/A	N/A	0.020	Lower terminus of crack was difficult to determine.
Crack 5	southeast elevation	90	>505	290	495	0.010	Top of crack could not be determined because it extended into painted portion of chimney. Condition of crack along majority of repaired section could not be determined because of restricted access.

Notes: N/A - Not Applicable (Crack was not repaired)

FIGURE 1

LAMBTON TGS CHIMNEY 2
Concrete Shell - Exterior Surface



Notes:

1) Sketch is not to scale.
(Horizontal dimensions have been exaggerated).

2) Inspection was conducted between 06 and 07 May 1988.

3) For summary of cracks see Table 1.

Legend

- Location of Crack
- Reported Location of Crack but not Accessible
- Previously Repaired Crack
- Terminus Point of Crack Marked on Chimney
- Spalled Section of Concrete at Elevation 440'

Figure 2: View of Lambton TGS Chimney 2, looking northwest

Figure 3: Elevation 415', northwest - Crack 2 divides into three sections at this location. The crack width ranges from 0.020" to 0.010".

Figure 4: Elevation 290', southwest - Crack 4 with a width of 0.010".

Figure 5: Elevation 15' - Typical cracks at the base of the concrete shell. The crack widths range from 0.010" to hairline.

Figure 6: Elevation 270', northwest - Previously repaired section of Crack 3.

Figure 7: Elevation 270', northwest - Previously repaired section of Crack 3 showing the open crack and weathered repair material.

Figure 8: Elevation 475', southeast - Crack 5 covered with paint and a dirty film common on the top portion of the chimney.

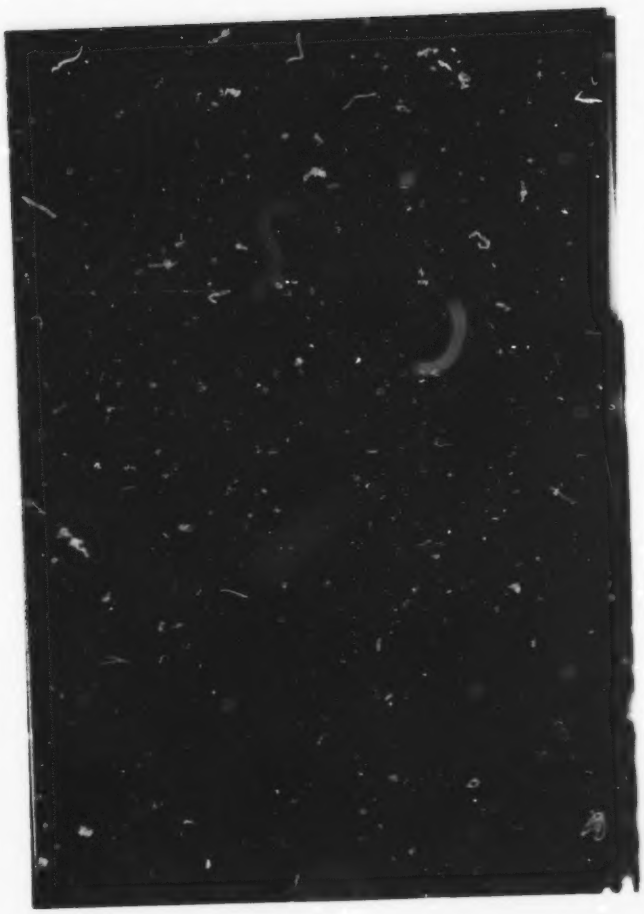


Figure 9: Elevation 280', southeast - Previously repaired section of Crack 5 showing the open crack and weathered repair material.

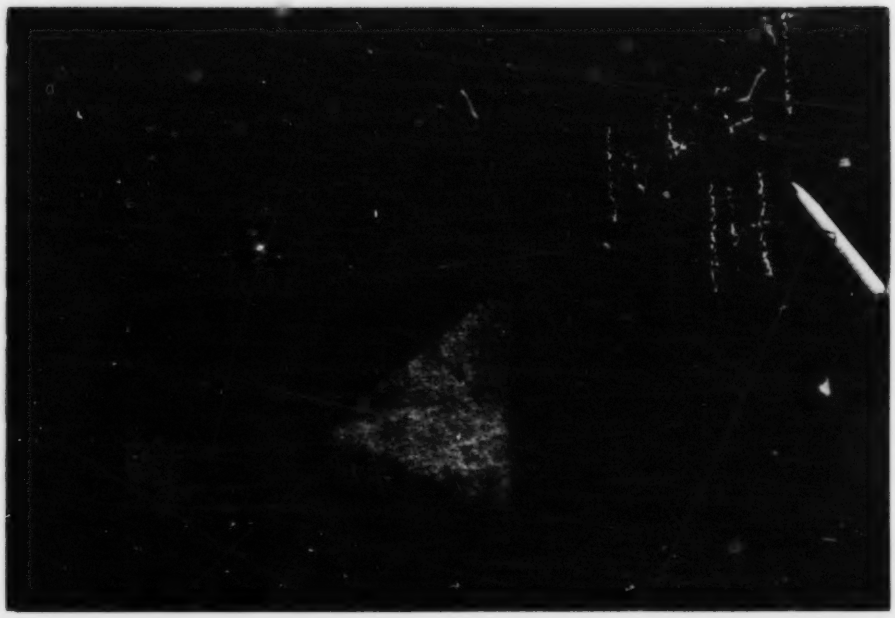


Figure 10: Elevation 450', northwest - Upper terminus of Crack 2. This is typical of the painted targets placed on the concrete to mark the terminus of the cracks.

Figure 11: Elevation 505', southeast - Crack 5 extending into the painted portion of the chimney. Crack width at this location is 0.010".

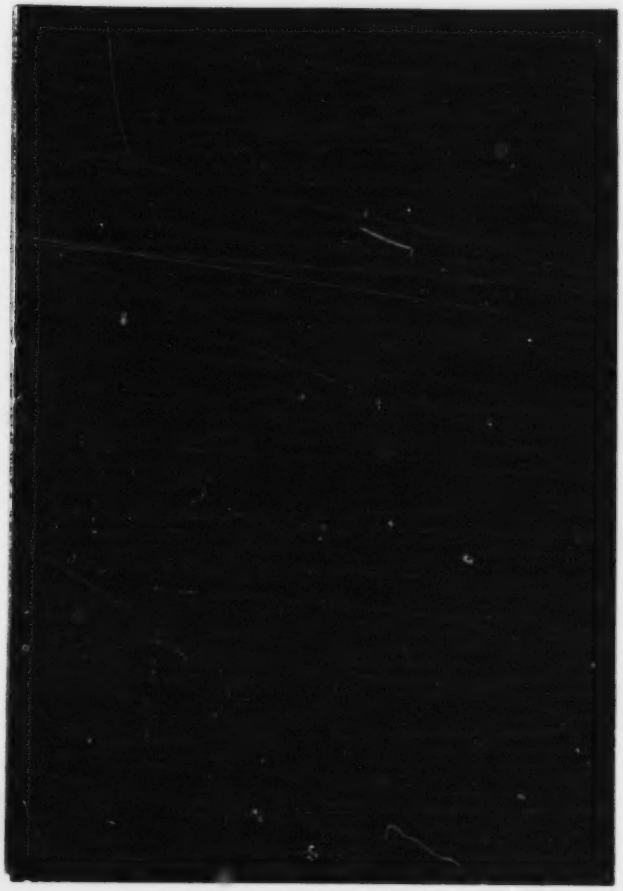


Figure 12: Elevation 90', southeast - Bottom terminus of Crack 5. At this location the crack is difficult to view because of the narrow crack width.

Figure 13: Elevation 440', northwest - Spalled section of concrete affecting approximately one square foot of the concrete surface.

Figure 14: Elevation 140', west - Exposed concrete showing the layer of fly ash covering the shell and the scaling of the concrete surface.

Figure 15: Elevation 30',west - Crack in the interior surface of the concrete shell. Crack width at this location is 0.030".

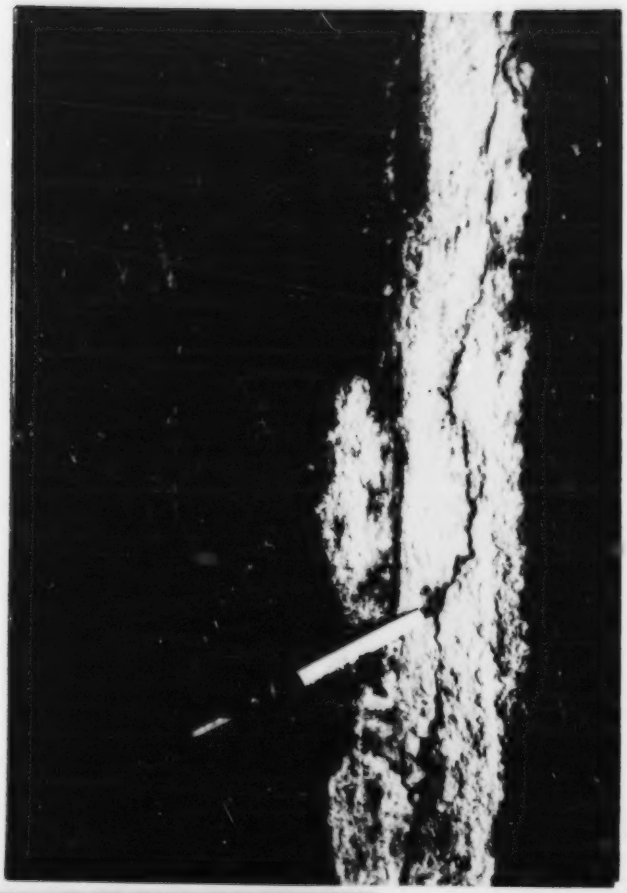


Figure 16: Elevation 460', west - Exposed crack with a width between 0.030" and 0.020". This crack may extend through the shell as part of Crack 3.

Figure 17: Elevation 1' - Deterioration of concrete at the base of the shell in the annular space. An accumulation of fly ash and water had been present prior to the inspection.

Figure 18: Elevation 4' - Crack around the circumference of the concrete base supporting the steel liner. The crack width ranges between 0.030" and 0.015".

Figure 19: Elevation 15' - Condition of concrete on the interior surface of the concrete base supporting the steel liner.